

## **From Tubewell to Tap: The Persistent Challenge of Safe Drinking Water in Rural India**

**Running Title:** Safe Drinking Water in Rural India

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**Abstract:** Ensuring universal access to safe water remains a challenge across rural India. In this viewpoint, we reflect on our observations regarding drinking water quality in a village in Haryana in northern India. We discuss how the issues we face are part of larger systemic issues in rural administration and healthcare. Despite a robust policy framework and several programmes over the decades, almost one-fourth of rural households still lack functional tap water connections, and there are wide regional inequalities. We attempt to dissect the social, administrative and environmental factors which contribute to these gaps. Improving water supply and quality in Indian villages can go a long way in achieving Sustainable Development Goal 6, and enhancing the health of millions of people. This needs coordinated efforts from various stakeholders, including community members, local administrations, state and central governments and healthcare professionals. In particular, we advocate for broader involvement of the health sector in water-related health across India, going beyond the traditional roles of quality monitoring, medical interventions and surveillance.

**Keywords:** Drinking water, Health policy, Rural India, Village

## Introduction

Access to safe drinking water is a fundamental human right and a cornerstone of public health. Sustainable Development Goal 6.1 targets access to safe drinking water for all people across the world by 2030 [1]. In rural areas of India, however, the reality often falls short of this ideal. Despite various governmental and non-governmental efforts to address water quality issues, many rural communities continue to face significant challenges related to water contamination [2]. This is particularly evident in regions such as Haryana, where historical data and recent surveys reveal persistent problems with water safety and public health [3].

Our team is involved in providing primary healthcare to rural areas in Haryana, a state in northern India, under our Department's broader Community Health Service Programme [4]. As part of this work, our team conducts comprehensive assessments of drinking water quality in a village in Haryana from time to time. In this village, groundwater is the primary source of drinking water. Electric pumps draw water from tubewells and supply them to the households through a network of pipes. A chlorine dosing unit located at the tubewell chlorinates the water before it enters the domestic supply network. The gram panchayat has the responsibility of maintaining this water supply system. When we tested water quality a decade ago, the results were alarming: the water had faecal contamination, and had inadequate free chlorine. Primary school children, crucially dependent on safe water for their health and well-being, were consuming this water from taps installed in their school. Our team shared these findings with the gram panchayat (the elected governing body of the village), which took corrective steps. The panchayat closed one tubewell which supplied contaminated water, and operationalised a new one. However, ten

years after this intervention, recent water sampling revealed that the water remains contaminated with coliform bacteria and has inadequate chlorine, indicating that the situation has not improved. Many villagers are compelled to install reverse osmosis (RO) purifiers in their homes, which are not only expensive but also waste water and electricity. Others, who cannot afford these purifiers and do not have time for boiling water, have no option but to consume the contaminated water.

National surveys and studies corroborate these findings, highlighting a broader issue across rural India. According to the National Family Health Survey (NFHS-5; 2019–21), less than one-fourth of rural households in India receive piped water directly to their home. Around 5% rely on unimproved drinking water sources such as surface water and unprotected wells. Further, for 1.6% of households, a round trip to collect water takes more than 30 minutes. In most such households, women are tasked with carrying water over such long distances [5]. Even when piped water is available, the water quality is often compromised by pollutants such as faecal coliforms, nitrates, and arsenic, which are linked to various waterborne diseases. The World Health Organization (WHO) estimates that in 2019, over 500,000 diarrhoeal deaths in low- and middle-income countries, i.e. 35% of all diarrhoeal deaths in these countries, were due to contaminated drinking water [6].

These statistics underscore a critical public health crisis. Availability of safe water does not only affect individual health; it also has profound impacts on community well-being, economic productivity, and educational outcomes [7]. Children, who are particularly vulnerable to the effects of unsafe water, suffer the most from preventable water-borne diseases, leading to high rates of school absenteeism and long-term health complications [8].

The persistent contamination of water sources, despite interventions, raises questions about the effectiveness of current strategies and the adequacy of infrastructure in rural areas. This article aims to explore the ongoing challenges of ensuring safe drinking water in rural India, examine the implications for public health, and discuss potential strategies for improving water safety and health outcomes in similar contexts across the country.

### **Evolution of rural infrastructure for safe drinking water: key policies and programmes in India**

India has a strong policy framework for provision of safe drinking water to all its residents. Though the Constitution of India does not explicitly mention access to drinking water as a right, the judiciary has consistently interpreted it as part of the fundamental right to life, under Article 21 [9]. As early as the First Five Year Plan (1951–56), the Government of India recognised the importance of safe drinking water for rural health [10]. The National Water Policy (1987) asserted that all urban and rural areas should have adequate drinking water supply, even going so far as to say that, ‘Drinking water needs of human beings and animals should be the first charge on any available water.’ [11]

The Government of India's efforts to improve rural water infrastructure have evolved significantly over the decades, marked by several key programmes and missions. Among the earliest of these programmes was the Accelerated Rural Water Supply Programme (ARWSP), launched in 1972. This programme allowed for Centrally sponsored infrastructure development for water supply in villages. In 1986, the Government revamped this programme and established a mission structure for decentralised planning at the state level. This National Drinking Water

Mission, launched in 1986, was renamed the Rajiv Gandhi National Drinking Water Mission (RGNDWM) in 1991. The Mission aimed to provide potable water amounting to at least 40 litres per capita per day (lcpd) for the rural population, with additional allowances for desert areas [12]. It emphasised improving infrastructure, increasing community participation, and focusing on sustainable water management. Under this Mission, the Government of India also launched the Swajaldhara initiative in 2002, to facilitate gram panchayats' ownership of the programme [13]. Despite these efforts, the Mission faced challenges in reaching remote areas and ensuring the sustainability of water sources. These were due to gaps in the state-level annual plans, financial irregularities, and inadequate facilities for water quality testing [12,14].

The National Rural Drinking Water Programme (NRDWP; 2009) succeeded the RGNDWM. It raised the bar for water availability in rural areas: it went beyond per capita average supply in habitations, and aimed to ensure drinking water availability at the household level. It had a special focus on populations with inadequate coverage and Scheduled Caste / Scheduled Tribe habitations [15]. Yet, a subsequent audit showed that the programme did not perform as hoped, due to the same lacunae that affected the RGNDWM. By 2017, only 17% of rural households had piped water connections, against the target of 35% [16].

In 2019, the Government of India renamed the NRDWP as Jal Jeevan Mission (JJM), with the motto, ‘*Har ghar nal se jal*’ (tap water for every home). The JJM aims to provide piped water supply to every rural household by 2024. It emphasises decentralised planning and implementation to improve infrastructure, expand coverage, and ensure the sustainability of water supply systems [17]. At the time of this

writing in September 2024, piped water supply under the Mission had reached an impressive 78% of all rural households. It is worth keeping in mind that some households with a piped water connection eventually lose access to water, because of lack of maintenance of the source or supply system. This phenomenon, called “slip-back”, has been seen in previous programmes [16]. Time will tell if this will be an issue with JJM. Further, as we have seen in our rural practice, even a functional piped water connection can supply contaminated water. Thus, piped water

supply should not be seen as an end in itself. It is a first step in the process of maintaining a safe water supply; a process which requires continuous and active efforts from all stakeholders.

### Statewide Comparison of Safe Drinking Water Availability

The availability of safe drinking water varies significantly across Indian states [Table 1]. It is influenced by factors such as infrastructure development, geographic conditions, and local governance.

**Table 1: Status of water supply and water quality in states and union territories of India**

	Proportion of rural households with piped water supply (%)	Number of water samples tested in laboratories	Number of samples found contaminated on laboratory examination	Proportion of samples found contaminated (%)
<b>States</b>				
Andhra Pradesh	73.4	2,58,501	1,158	0.4
Arunachal Pradesh	100.0	9,895	0	0.0
Assam	81.0	1,19,003	1,937	1.6
Bihar	96.1	1,06,110	13,893	13.1
Chhattisgarh	78.7	46,933	369	0.8
Goa	100.0	5,953	9	0.2
Gujarat	100.0	28,598	2,114	7.4
Haryana	100.0	21,493	1,110	5.2
Himachal Pradesh	100.0	1,04,204	15	0.0
Jharkhand	54.3	99,984	6	0.0
Karnataka	78.8	1,27,203	8,884	7.0
Kerala	53.6	2,39,507	26,959	11.3
Madhya Pradesh	64.9	2,28,921	383	0.2
Maharashtra	86.6	2,38,225	15,812	6.6
Manipur	79.6	11,392	0	0.0
Meghalaya	80.6	20,405	90	0.4
Mizoram	100.0	10,686	624	5.8
Nagaland	92.2	2,239	4	0.2
Odisha	74.6	1,22,335	1,851	1.5
Punjab	100.0	31,553	83	0.3
Rajasthan	53.0	94,839	7,982	8.4
Sikkim	89.2	1,892	438	23.2
Tamil Nadu	86.1	4,06,968	24	0.0
Telangana	100.0	1,16,964	3	0.0
Tripura	83.2	35,257	387	1.1

	Proportion of rural households with piped water supply (%)	Number of water samples tested in laboratories	Number of samples found contaminated on laboratory examination	Proportion of samples found contaminated (%)
Uttar Pradesh	85.0	4,73,492	1,296	0.3
Uttarakhand	96.2	52,303	62	0.1
West Bengal	52.4	2,36,701	77,789	32.9
Union Territories				
Andaman and Nicobar Islands	100.0	322	79	24.5
Dadra and Nagar Haveli and Daman and Diu	100.0	0	0	—
Jammu and Kashmir	79.9	1,08,335	50	0.0
Ladakh	94.9	5,736	93	1.6
Lakshadweep	90.8	3,212	53	1.7
Puducherry	100.0	214	39	18.2

Data obtained from the piped water supply (<https://ejalshakti.gov.in/jjmreport/JJMIndia.aspx>) and water quality (<https://ejalshakti.gov.in/WQMIS/>) dashboards of the Jal Jeevan Mission on September 10, 2024.

By September 2024, four states and three Union Territories had been certified as ‘Har Ghar Jal,’ meaning that they had achieved 100% coverage of rural households with piped water [18]. Haryana is one of these states.

During the year 2024, laboratory testing showed that most water samples collected were satisfactory. However, in some states and union territories such as Sikkim, West Bengal, and Andaman and Nicobar Islands, over 20% of the water samples were found to be contaminated [Table 1]. About 5% of the samples collected from villages in Haryana were contaminated [19]. These findings reiterate that maintaining quality of piped water is still a challenge in many parts of India.

### Why is drinking water availability greater in some states of India?

The significant disparities in the availability of safe drinking water across

Indian states can be attributed to a complex interplay of factors. Understanding these reasons requires examining various elements including rural infrastructure, education, rural development, administrative and governance capabilities, and political forces [Table 2].

#### 1. Rural infrastructure and development

**Infrastructure** is a major determinant of water supply quality and availability. States which have historically had water purification and distribution systems in place find it easier to expand piped water supply [20]. This is why some states like Punjab, Himachal Pradesh, Sikkim and Gujarat have high coverage of piped water supply. Conversely, states such as Kerala and Jharkhand need to establish additional infrastructure for drinking water delivery.

**Table 2: Factors affecting rural safe water access in states of India**

<b>Factor</b>	<b>Examples of states with favourable conditions for access to safe water</b>	<b>Examples of states with unfavourable conditions for access to safe water</b>
<b>Rural infrastructure and development</b>	Punjab, Himachal Pradesh, Sikkim, Gujarat	Kerala, Jharkhand
<b>Social and economic development</b>	Goa, Himachal Pradesh, Mizoram	Jharkhand, Odisha, Chhattisgarh
<b>Governance</b>	Sikkim, Himachal Pradesh	West Bengal, Uttar Pradesh
<b>Political stability</b>	Tamil Nadu	Assam, Jharkhand
<b>Environmental factors</b>	Tamil Nadu	Rajasthan

## ***2. Social and economic development***

Social and economic development empower communities. Such empowered communities can effectively influence policymakers and administrators to ensure safe water supply. For example, states with high literacy levels—Goa, Himachal Pradesh, Mizoram—tend to have higher access to safe water [5]. Caste inequalities also contribute to disparities in water access. Scheduled Tribes and Scheduled Castes have historically been some of the most vulnerable communities in the Indian social structure, and states with large populations from these communities—Jharkhand, Odisha and Chhattisgarh—find it difficult to ensure safe water delivery for them [21].

## ***3. Administrative and Governance Abilities***

Administrative efficiency and governance are crucial for implementing water safety measures effectively. States with effective administrative frameworks and strong governance, such as Himachal Pradesh and

Sikkim, are more successful in maintaining high levels of safe water supply. In contrast, states with weaker governance structures may face inefficiencies in water management and delivery, contributing to lower levels of safe water availability. States like West Bengal and Uttar Pradesh need to overcome such administrative challenges that impact water safety [22].

## ***4. Political stability***

**Political influence** can affect the allocation of resources and prioritisation of water safety initiatives. States with stable political environments and effective local leadership, such as Tamil Nadu, are better able to implement and sustain water safety measures. States facing political instability or frequent changes in leadership may experience delays in implementing water safety programmes. This can lead to disparities in safe water access, as seen in some northeastern states.

## ***5. Geographical and environmental Factors***

Even where water is piped to rural homes, the supply is primarily sourced from underground aquifers. Thus, it is no surprise that states which are richly endowed with groundwater, such as Tamil Nadu, can more easily provide safe drinking water in villages. States with challenging conditions, such as Rajasthan, where ground water is over 40 metres below ground level in many places, need additional efforts to provide safe water to rural residents [23].

Thus, the disparities in rural safe water supply across Indian states are multifaceted. Addressing these disparities requires a holistic approach that includes improving rural infrastructure, poverty alleviation and education, empowering backward communities, strengthening governance, and considering local environmental conditions. Local bodies and district administrations can also contribute immensely in these measures. We discuss next the role of decentralisation in safe water delivery.

### **Role of gram panchayats and district administrations**

The theme of decentralisation comes up in all rural water supply programmes in India. Over the past decades, the Government of India has increasingly taken the role of enabler and funder for rural water delivery, leaving the planning, implementation and maintenance aspects to gram panchayats, districts and states. Gram panchayats shoulder several important responsibilities for delivery of safe water.

First, panchayats play a pivotal role in educating the local community about the importance of safe drinking water and sanitation. They organise awareness campaigns and workshops to promote good hygiene practices and the use of safe water [24]. They also encourage community participation in maintaining water sources

and sanitation facilities, fostering a culture of cleanliness and safety.

Second, panchayats are involved in the planning and execution of water supply infrastructure projects [25]. They ensure that water sources such as tube wells, hand pumps, and pipelines are installed and maintained properly. Panchayats oversee the day-to-day operations of water supply systems, including regular maintenance and repairs. They ensure that water sources are functional and that any issues are addressed promptly.

Third, panchayats manage local budgets for water supply and sanitation projects. They allocate funds for infrastructure development, repairs, and upgrades. In addition, they mobilise local resources and labor for the construction and maintenance of water facilities, leveraging community support and participation.

Finally, panchayats also monitor the quality and quantity of water supplied to the community. They conduct regular inspections to ensure that water sources are not contaminated and that safety standards are upheld. Feedback from the panchayat acts as a bridge between the community and higher administrative levels, reporting issues to district authorities [26].

District administrations also play crucial roles in ensuring safe water access. They provide oversight and coordination for water supply and sanitation projects. They are also responsible for disbursing funds and grants for water supply projects, and ensuring transparency [27]. Monitoring of water supply and quality is also done at the district level. In cases of water contamination or shortages, district administrations coordinate emergency responses, including temporary water supply solutions and health interventions.

Many have welcomed the decentralisation of rural water delivery in India, stating that

local communities are most knowledgeable about the contexts in which they live. Therefore, they are best placed to make decisions about their water supply [28]. While this argument seems valid theoretically, practical experience has shown that gram panchayats often lack the expertise needed for infrastructure maintenance and quality assurance in water supply. In fact, an econometric analysis of district- and state-level Indian data from 2013 to 2019 found that devolution of responsibilities to gram panchayats was *negatively* associated with piped water supply coverage [20]. We contend that village-level planning and implementation for water delivery are likely to succeed only if gram panchayats are enabled for these activities. For this, the Central and state governments need to develop panchayats' technical and managerial capacities, and minimise procedural inefficiencies (e.g. corruption) [29].

### **Role of the health sector**

The role of water in human health is so crucial that in many states of India, water and sanitation departments are called 'Public Health Engineering Departments'. However, these departments are staffed mainly by engineers, who have limited understanding of public health principles [30]. On the other hand, core health-related functions pertaining to water are vested in the government health system [Figure 1]. In

fact, the Indian Public Health Standards stipulate certain water supply-related responsibilities that rural primary health centres must carry out [31]:

#### ***1. Quality testing***

Health departments conduct regular testing of water sources to ensure compliance with safety standards. They analyse samples for contaminants and take corrective actions if necessary. Thus, they help enforce standards for water quality.

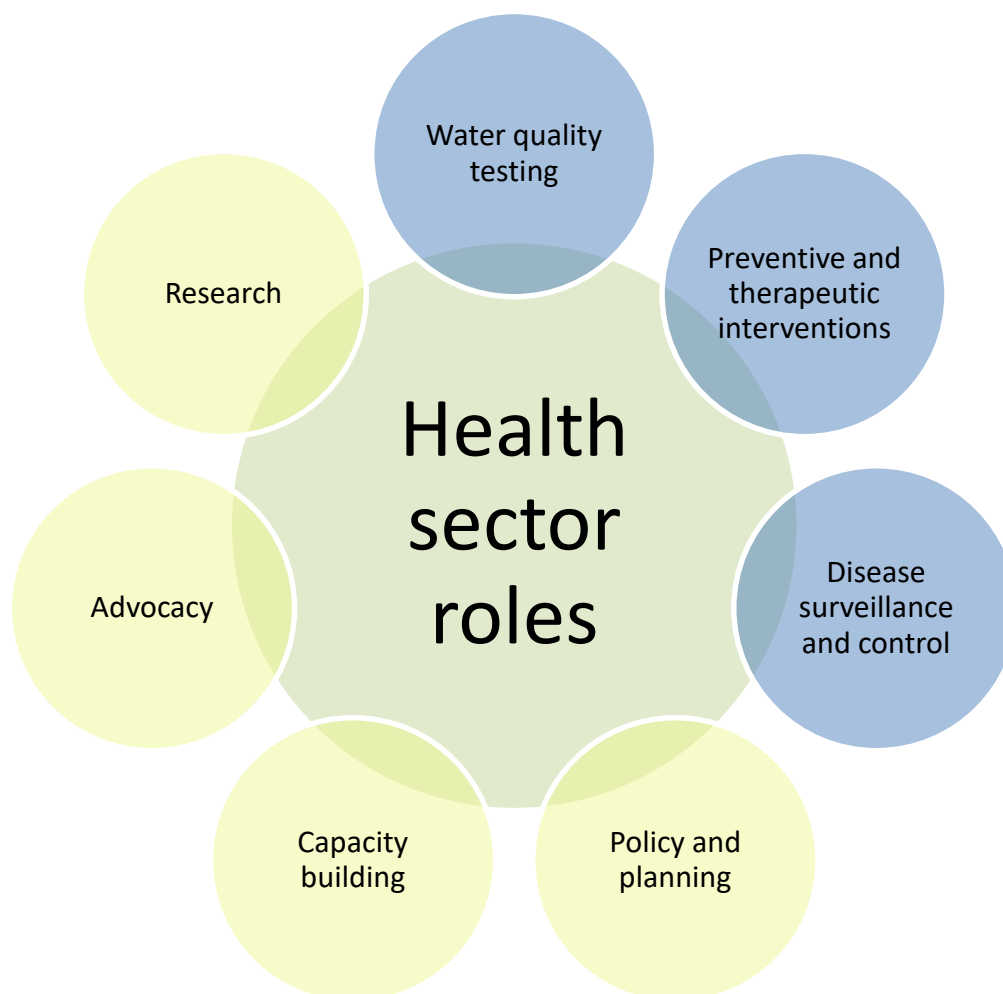
#### ***2. Preventive and therapeutic interventions***

Primary health centres provide medical treatment and support to individuals affected by waterborne diseases. They also implement vaccination programmes and other preventive measures to protect communities from waterborne diseases such as rotavirus infection and typhoid.

#### ***3. Disease surveillance and control***

Health departments monitor waterborne disease outbreaks and investigate cases of illness related to water contamination. They track trends and implement control measures as needed. They also provide education on the health impacts of unsafe water and promote preventive measures to reduce the incidence of waterborne diseases.





**Figure 1: A schematic of the roles which the health sector in India (including individual-focused providers and practitioners of public health) can play in ensuring safe water delivery in rural areas. The blue circles show roles which the Indian health sector is already engaged in. The yellow circles show additional roles which the health sector needs to take up.**

### **How can public health departments contribute?**

The health sector can be an important partner and advocate for enabling access to safe water in villages. Considering the social justice aspects of access to safe water that we discussed earlier, the role of the government healthcare system becomes even more important. There is scope for greater involvement of public health professionals in ensuring rural water supply. We envision this involvement happening in several ways [Figure 1]. Health departments can participate in

formulating policies and strategies for improving water quality. They can contribute scientific knowledge to development of guidelines and best practices for rural water supply management. They can also build local capacity, by training other functionaries in water quality management. Leveraging their connections with the community, health departments can conduct national and regional advocacy campaigns, to involve the community in decisions about water safety. They can also use various media and outreach methods to educate the public and policymakers. Lastly, health

professionals can contribute by conducting research on water-related health issues. They can identify trends and inform policy decisions. They can also monitor the effectiveness of water safety programmes and interventions.

### Conclusion

Despite progress in recent decades, much remains to be achieved for safe water supply in India, especially in Haryana. The effective provision and monitoring of safe drinking water in rural areas depend on a collaborative approach involving local panchayats, district administration, and public health departments. Each entity plays a distinct but complementary role in ensuring that water supply systems are well-managed, safe, and sustainable. By working together, these organisations can address the challenges of water safety and improve public health outcomes in rural communities.

### Ethical considerations

This article comments on the existing public health situation in different parts of India. No human research participants were involved in this work.

### Conflict of interest

The authors declare that they have no conflicting interests.

### Author contributions

Arun Kumar Aggarwal: Conceptualisation; writing—original draft; writing—review and editing; supervision. Adhish Kumar Sethi: Conceptualisation; writing—review and editing; visualisation. Navneet Gupta: Writing—review and editing. Tanvi Kiran: Writing—review and editing; supervision.

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